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Class U.S. PTO**UTILITY PATENT APPLICATION TRANSMITTAL
(Small Entity)**

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Docket No.
KAM1-BL27

Total Pages in this Submission

TO THE ASSISTANT COMMISSIONER FOR PATENTSBox Patent Application
Washington, D.C. 20231

Transmitted herewith for filing under 35 U.S.C. 111(a) and 37 C.F.R. 1.53(b) is a new utility patent application for an invention entitled:

NEGATIVE ION EMITTING METHOD AND APPARATUS THEREFOR

and invented by:

Yoichi KatoIf a **CONTINUATION APPLICATION**, check appropriate box and supply the requisite information:☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____Which is a: ☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____Which is a: ☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____

Enclosed are:

Application Elements

1. ☒ Filing fee as calculated and transmitted as described below
2. ☒ Specification having 20 pages and including the following:
 - a. ☒ Descriptive Title of the Invention
 - b. ☐ Cross References to Related Applications (if applicable)
 - c. ☐ Statement Regarding Federally-sponsored Research/Development (if applicable)
 - d. ☐ Reference to Microfiche Appendix (if applicable)
 - e. ☒ Background of the Invention
 - f. ☒ Brief Summary of the Invention
 - g. ☒ Brief Description of the Drawings (if drawings filed)
 - h. ☒ Detailed Description
 - i. ☒ Claim(s) as Classified Below
 - j. ☒ Abstract of the Disclosure

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06/09/00

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Application Elements (Continued)

3. ☒ Drawing(s) *(when necessary as prescribed by 35 USC 113)*
a. ☒ Formal b. ☐ Informal Number of Sheets seven (7)
4. ☒ Oath or Declaration
a. ☒ Newly executed *(original or copy)* ☐ Unexecuted
b. ☐ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional application only)*
c. ☒ With Power of Attorney ☐ Without Power of Attorney
d. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application,
see 37 C.F.R. 1.63(d)(2) and 1.33(b).
5. ☐ Incorporation By Reference *(usable if Box 4b is checked)*
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under
Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby
incorporated by reference therein.
6. ☐ Computer Program in Microfiche
7. ☐ Genetic Sequence Submission *(if applicable, all must be included)*
a. ☐ Paper Copy
b. ☐ Computer Readable Copy
c. ☐ Statement Verifying Identical Paper and Computer Readable Copy

Accompanying Application Parts

8. ☒ Assignment Papers *(cover sheet & documents)*
9. ☐ 37 CFR 3.73(b) Statement *(when there is an assignee)*
10. ☐ English Translation Document *(if applicable)*
11. ☒ Information Disclosure Statement/PTO-1449 ☒ Copies of IDS Citations
12. ☒ Preliminary Amendment
13. ☒ Acknowledgment postcard
14. ☒ Certificate of Mailing
☐ First Class ☒ Express Mail *(Specify Label No.):* EL230378919US

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Accompanying Application Parts (Continued)

15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. ☒ Small Entity Statement(s) - Specify Number of Statements Submitted: one (1)
17. ☐ Additional Enclosures (please identify below):

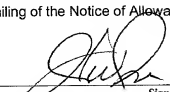
Fee Calculation and Transmittal

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	17	- 20 =	0	x \$9.00	\$0.00
Indep. Claims	2	- 3 =	0	x \$39.00	\$0.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
BASIC FEE					\$345.00
OTHER FEE (specify purpose) Assignment Recordation Fee					\$40.00
TOTAL FILING FEE					\$385.00

- ☒ A check in the amount of \$385.00 to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. 16-2462 as described below. A duplicate copy of this sheet is enclosed.
- ☐ Charge the amount of as filing fee.
- ☒ Credit any overpayment.
- ☒ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: June 9, 2000


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SMALL ENTITY STATEMENT

Applicant(s): Yoichi Kato
Title: NEGATIVE ION EMITTING METHOD AND
APPARATUS THEREFOR
Attorney's
Docket No.: KAM1-BL27

"EXPRESS MAIL" MAILING
LABEL NO. EL230378919US

DATE OF DEPOSIT: June 9, 2000

Applicant or Patentee: Yoichi Kato Attorney's
Serial or Patent No.: _____ Docket No.: KAM1-BL27
Filed or Issued: _____
For: NEGATIVE ION EMITTING METHOD AND APPARATUS THEREFOR

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY
STATUS (37 CFR 1.9 (f) and 1.27 (c)) — SMALL BUSINESS CONCERN

I hereby declare that I am

- ☐ the owner of the small business concern identified below;
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN Lambda Co., Ltd.
ADDRESS OF CONCERN 42-13, Kabukicho 2-chome, Shinjuku-ku, Tokyo, Japan

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9 (d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled Negative ion emitting method and apparatus therefor by inventor(s) Yoichi KATOU described in

- ☒ the specification filed herewith
☐ application serial no. _____, filed _____
☐ patent no. _____, issued _____

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9 (d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9 (d) or a nonprofit organization under 37 CFR 1.9 (e).

*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME _____
ADDRESS _____
☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

NAME _____
ADDRESS _____
☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28 (b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Mitsuo UEDA
TITLE OF PERSON OTHER THAN OWNER President
ADDRESS OF PERSON SIGNING c/o Lambda Co., Ltd.
42-13, Kabukicho 2-chome, Shinjuku-ku, Tokyo, Japan

SIGNATURE Mitsuo Ueda DATE June 5, 2000

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PRELIMINARY AMENDMENT

Applicant(s):

Yoichi Kato

Title:

NEGATIVE ION EMITTING METHOD AND
APPARATUS THEREFOR

Attorney's

Docket No.:

KAM1-BL27

"EXPRESS MAIL" MAILING
LABEL NO. EL230378919US

DATE OF DEPOSIT: June 9, 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Yoichi Kato

Serial No.:

Filed:

Title: NEGATIVE ION EMITTING METHOD AND
APPARATUS THEREFOR

Examiner:

Group Art Unit:

June 9, 2000

Irvine, California 92614

PRELIMINARY AMENDMENTAssistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to an examination of the merits in the above-identified application, please enter the following amendments.

IN THE SPECIFICATION

On Page 1, Line 5, insert --Field of the Invention--;

Line 7, insert --Description of the Related Art--;

Line 14, after "between" insert --the--;

Line 14, after "to" insert --the--.

On Page 2, Line 15, delete "require" and insert --requires--;

Line 20, delete "fail" and insert --a failure--.

On Page 5, Line 19, after “blocking” insert --the--.

On Page 6, Line 13, delete “Then” and insert --When--.

On Page 8, Line 19, delete “Then” and insert --When--.

IN THE SPECIFICATION

Please add the following newly drafted Claims 18-20:

1 18. A negative ion emitting apparatus as in Claim 3 wherein the load resistance section
2 includes carbon having a resistance of 20 Ω and the DC high-voltage power supply section can
3 provide 5kV.

1 19. A negative ion emitting apparatus as in Claim 9 wherein the load resistance section
2 is carbon in each of said discharge electrode sections and the additional load resistance section in
3 the distributor is carbon.

1 20. A negative ion emitting apparatus as in Claim 19 wherein the respective carbon
2 sections have a resistance of 20 Ω and the DC high-voltage power supply section can provide 5kV.

REMARKS

The proposed corrections in the specifications are to address minor grammatical matters and do not add any new matter. The additional dependent claims are within the scope of the original claims.

Attached hereto is a PTO Form 1449 for consideration by the Examiner.

If the Examiner believes a telephone interview will help further the prosecution of this case, he is respectfully requested to contact the undersigned attorney at the listed telephone number.

Respectfully submitted,

PRICE, GESS & UBELL



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SPECIFICATION, CLAIMS AND ABSTRACT

Applicant(s):

Yoichi Kato

Title:

NEGATIVE ION EMITTING METHOD AND
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Attorney's

Docket No.:

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"EXPRESS MAIL" MAILING
LABEL NO. EL230378919US

DATE OF DEPOSIT: June 9, 2000

TITLE OF THE INVENTION

NEGATIVE ION EMITTING METHOD AND APPARATUS THEREFOR

BACKGROUND OF THE INVENTION

5 This invention relates to a negative ion emitting method and an apparatus therefor.

A conventional negative ion emitting apparatus is generally constructed in such a manner that electrons or negative ions are emitted from a negative electrode set at a high voltage relative to a ground voltage to a positive electrode set at a high voltage. This is commonly called a corona discharge system.

10 Unfortunately, the corona discharge system has some important problems. One of the problems is that ozone is generated in air between discharge electrodes due to corona discharge. Another problem is that it causes generation of positive ions on a side of the positive electrode concurrently with generation of ozone.

15 Now, the conventional negative ion emitting apparatus will be described with reference to Fig. 9 together with a mechanism for absorbing ozone and positive ions. The conventional negative ion emitting apparatus includes a negative electrode 1 which is formed at a distal end thereof with an acute angle, as shown on a right side in Fig. 9. Also, it includes a positive electrode 9 of a cylindrical configuration arranged so as to receive negative ions emitted from the negative electrode. The positive electrode 9 is shown on a left side in Fig. 9. Reference numeral 2 designates an electrode support and 6 is a high-voltage power supply.

20 The conventional negative ion emitting apparatus further includes a first filter 10 arranged between the positive electrode 9 and the negative electrode 1. The first filter 10 has activated carbon incorporated therein, which functions to

absorb ozone thereon, to thereby prevent ingress of ozone to the positive electrode 9.

The cylindrical positive electrode 9 is provided therein with a second filter 11 for absorbing positive ions generated due to the corona discharge thereon. To this end, the second filter 11 has a catalyst for absorbing positive ions added thereto.

The above-described construction of the conventional negative ion emitting apparatus permits ozone and positive ions thus generated to be effectively absorbed on the way to a negative ion storage section, so that only negative ions may be guided through the positive electrode 9 to the negative ion storage section.

Unfortunately, the above-described construction of the conventional negative ion emitting apparatus causes the apparatus to be complicated in structure and require the above-described mechanism for absorbing ozone and positive ions. Also, the mechanism must be periodically replaced. In addition, the conventional negative ion emitting apparatus often causes neutralization of negative ions with positive ions on the way to the negative ion storage section, resulting in fail to exhibit satisfactory efficiency.

SUMMARY OF THE INVENTION

The present invention has been made in view of the foregoing disadvantages of the prior art.

Accordingly, it is an object of the present invention to provide a negative ion emitting apparatus which is capable of effectively emitting electrons or negative ions without requiring any mechanism for absorbing ozone and positive ions.

It is another object of the present invention to provide a negative ion emitting method which is capable of effectively emitting electrons or negative ions without requiring any

mechanism for absorbing ozone and positive ions.

In accordance with one aspect of the present invention, a negative ion emitting apparatus is provided. The negative ion emitting apparatus includes a DC high-voltage power supply section, at least one discharge electrode section, and at least one load resistance section arranged between the DC high-voltage power supply section and the discharge electrode section so as to restrict flowing of electrons from the DC high-voltage power supply section to the discharge electrode section.

In a preferred embodiment of the present invention, the DC high-voltage power supply section is connected to the load resistance section and discharge electrode section through a high-voltage wiring.

In a preferred embodiment of the present invention, the discharge electrode section is constituted by a needle electrode formed at a distal end thereof with an acute angle.

In a preferred embodiment of the present invention, the amount of negative ions emitted is varied by varying a load resistance of the load resistance section.

In a preferred embodiment of the present invention, a plurality of the discharge electrode sections are arranged, a distributor is arranged between the discharge electrode sections and the DC high-voltage power supply section and provided therein with an additional load resistance section, and the DC high-voltage power supply section and the discharge electrode sections are connected to the distributor.

In accordance with another aspect of the present invention, a negative ion emitting method is provided. The negative ion emitting method includes the step of connecting at least one load resistance section between a DC high-voltage power supply section and at least one discharge electrode section, to thereby restrict flowing of electrons from the DC high-voltage

power supply section to the discharge electrode section for emission of negative ions from the discharge electrode section.

BRIEF DESCRIPTION OF THE DRAWINGS

5 These and other objects and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings; wherein:

10 Fig. 1 is a side elevation view showing an embodiment of a negative ion emitting apparatus according to the present invention;

15 Fig. 2 is a side elevation view showing another embodiment of a negative ion emitting apparatus according to the present invention;

 Fig. 3 is a schematic view showing measurement of negative ions emitted from the negative ion emitting apparatus according to the present invention;

20 Figs. 4 to 7 each are a graphical representation showing results of the measurement in Fig. 3;

 Fig. 8 is a schematic view showing sampling of gas generated from each of the negative ion emitting apparatus of the present invention and a conventional air cleaner; and

25 Fig. 9 is a side elevation view showing a conventional negative ion emitting apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 A negative ion emitting apparatus according to the present invention will be described hereinafter with reference to the accompanying drawings.

 Referring first to Fig. 1, an embodiment of a negative ion emitting apparatus according to the present invention is

illustrated. A negative ion emitting apparatus of the illustrated embodiment includes a needle electrode 1 acting as a discharge electrode section for emitting negatively charged electrons. The needle electrode 1 is made of a conductive metal material and pointed at a distal end thereof or formed at the distal end with an acute angle like a needle. The needle electrode 1 is supported in an electrode support 2 so that the distal end of the needle electrode 1 is outwardly projected from the electrode support 2. The electrode support 2 is made of an insulating material and formed to have a box-like configuration. The electrode support 2 has a load resistance section 3 arranged therein and the needle electrode 1 is connected at a proximal end thereof to the load resistance section 3. The needle electrode 1 is preferably made of a conductive metal material such as titanium or the like which is harmless to the human body and hard to round at the distal end thereof by discharge. Titanium or the like may be suitably used for this purpose.

The load resistance section 3 is constructed so as to function as a pressure unit of a kind for blocking flowing of electrons until a DC high voltage applied to the load resistance section 3 exceeds a predetermined limit level. The electrode support 2 may be made of, for example, a Derlin (trademark) or Teflon (trademark) material of a cylindrical shape and the load resistance section 3 may be made of, for example, carbon.

The electrode support 2 is securely mounted on a support base 4 using any suitable means. The load resistance section 3 is connected through a high-voltage wiring 5 to a DC high-voltage power supply section 6 constituted by a DC high-voltage power supply unit.

In the illustrated embodiment, a motor-driven fan (not shown) may be arranged behind the needle electrode 1, to thereby forcibly forwardly guide negative ions emitted from the needle

electrode 1.

In the negative ion emitting apparatus of the illustrated embodiment thus constructed, when a high voltage is applied from the DC high-voltage power supply section 6 through the high-voltage wiring 5 toward the needle electrode 1, negatively charged electrons are apt to be directed through the high-voltage wiring 5 toward the needle electrode 1. However, the load resistance section 3 arranged between the needle electrode 1 and the high-voltage wiring 5 blocks flowing of the electrons to the needle electrode 1.

Thus, the negatively charged electrons are filled in the wiring 5 before the load resistance section 3 due to the blocking by the load resistance section 3. Then, the DC high-voltage applied exceeds a predetermined limit level, it forcibly expels the electrons through the load resistance section 3 to the needle electrode 1, so that the electrons or negative ions may be emitted from the needle electrode 1.

The atmospheric air constantly contains moisture in an amount of about 30%. This results in hydrogen ions (positive ions) in the moisture always floating in the air. In addition to the hydrogen ions, a variety of other positive ions are likewise present in the air. Presence of such positive ions in the air permits the air to be regarded as a virtual positive electrode, so that discharge might occur in the air. In this instance, the above-described construction of the illustrated embodiment permits an impedance of the load resistance section 3 to be increased as compared with that between the virtual positive electrode and the needle electrode 1, leading to emission of electrons or negative ions from the needle electrode 1.

Such emission of electrons or negative ions from the needle electrode 1 requires matching between a power voltage of

the high-voltage power supply section 6 and a resistance of the load resistance section 3. For example, setting of a power supply of the high-voltage power supply and a resistance of the load resistance section at 5 kV and 20 Ω leads to emission of negative ions from the needle electrode 1. Such emission of negative ions from the negative ion emitting apparatus of the illustrated embodiment was confirmed by luminescence of a fluorescent tube obtained due to approaching of the apparatus to the fluorescent tube.

Referring now to Fig. 2, another embodiment of a negative ion emitting apparatus according to the present invention is illustrated. A negative ion emitting apparatus of the illustrated embodiment includes three needle electrodes 1a, 1b and 1c, electrode supports 2a, 2b and 2c in which the needle electrodes 1a, 1b and 1c are arranged and which have load resistance sections 3a, 3b and 3c arranged therein, respectively, and support bases 4a, 4b and 4c for supporting the electrode supports 2a, 2b and 2c thereon. The needle electrodes 1a, 1b and 1c are connected through a common distributor 7 to a common high-voltage power supply section 6. The needle electrodes 1a, 1b and 1c are connected through high-voltage wirings 5a, 5b and 5c to the distributor 7. The distributor 7 and high-voltage power supply section 6 are connected to each other through a single high-voltage wiring 5.

In the illustrated embodiment, the respective three needle electrodes, electrode supports, support bases and high-voltage wirings are arranged. However, they are not limited to such number. Thus, the respective two or four components may be arranged.

The distributor 7 includes a housing made of an insulating material and has a load resistance section 8 arranged therein. The load resistance section 8 may be constructed in the

same manner as the load resistance sections 3a to 3c. The high-voltage wiring 5 and high-voltage wirings 5a to 5c are connected to each other through the load resistance section 8. The load resistance section 8 functions to block flowing of negatively charged electrons from the high-voltage power supply section 6 thereto and equalize distribution of electrons to the needle electrodes 1a to 1c, to thereby permit the needle electrodes 1a to 1c to equally emit electrons or negative ions.

In the negative ion emitting apparatus of the illustrated embodiment thus constructed, when the DC high-voltage power supply section 6 is activated for application of a high voltage, it discharges negatively charged electrons. However, the negatively charged electrons are prevented from flowing through the high-voltage wiring 5 to the load resistance section 8 arranged between the high-voltage wiring 5 and the high-voltage wirings 5a to 5c by the load resistance section 8.

This results in the negatively charged electrons being filled in the wiring 5, thus, it will be noted that the load resistance section 8 acts as a pressure unit of a kind. Then, the high-voltage applied exceeds a predetermined level, the load resistance section 8 tries to forcibly discharge the filled negatively charged electrons through the high-voltage wirings 5a to 5c toward the needle electrodes while equally distributing the negatively charged electrons to the wirings. However, the negatively charged electrons are prevented from flowing to the needle electrodes 1a, 1b and 1c by the lead resistance sections 3a, 3b and 3c respectively arranged between the high-voltage wirings 5a, 5b and 5c and the needle electrodes 1a, 1b and 1c.

This causes negatively charged electrons to be filled in the high-voltage wirings 5a to 5c. Then, when filling of the negatively charged electrons in the wirings exceeds a predetermined level, the electrons are forcibly equally

distributed to the needle electrodes 1a, 1b and 1c, which are then equally emitted from the needle electrodes 1a, 1b and 1c, respectively.

As described above, the negative ion emitting apparatus of the present invention is so constructed that at least one load resistance section is connected between the DC high-voltage power supply section and at least one discharge electrode section to restrict flowing of electrons, leading to emission of negative ions. Such construction permits generation of negative ions without requiring any positive electrode. Thus, the present invention effectively eliminates generation of ozone due to corona discharge and generation of positive ions and by-products by a positive electrode, resulting in a structure of the negative ion emitting apparatus of the present invention being simplified and maintenance thereof being facilitated. Also, the present invention is increased in efficiency of emission of negative ions.

The present invention will be more readily understood with reference to the following example; however, these examples are intended to illustrate the invention and not to be constructed to limit the scope of the invention.

Example 1

The negative ion emitting apparatus of the present invention constructed as shown in Fig. 1 was used in the example, wherein the DC high-voltage power supply section was constituted by a high-pressure power supply manufactured by Logy Denshi Kabushiki Kaisha and the needle electrode was made of titanium. A voltage at the high-voltage power supply section and a resistance of the load resistance section were set to be 5 kV and 20 Ω , respectively, resulting in negative ions emitted from the needle electrode being measured.

The measurement was carried out using ion system measuring equipment commercially available under a tradename MODEL KST-900 from Kobe Denpa Kabushiki Kaisha. The measuring conditions were as follows:

Ions measured: Positive and negative ions,

Mobility: $0.4 \text{ cm}^2/\text{V} \cdot \text{sec}$ or more

Space charge density: Difference between the number of positive ions and that of negative ions in the total number of ions

Environment for measurement: Environment in a normal atmospheric air or environment containing ions in high concentration generated in atmospheric air

Measurement range: 5 to 999900 ions/cc

Minimum resolution in measurement: 5 ions/cc

Flow rate during sampling: 60 l/min

Measurement place: Meeting room, Kobe Denpa Kabushiki Kaisha

Measurement temperature: Room temperature (21°C)

The measurement was carried out as shown in Fig. 3. More specifically, the measurement equipment 13 described above was placed at a location spaced by 1 m from the negative ion emitting apparatus 12. The measurement equipment 13 was arranged so as to permit ions to pass above a sampling inlet 14 of the equipment 13. The measurement was carried out about 300 times for five minutes from each of times 14:45, 15:00, 15:15 and 15:35, after actuation of the negative ion emitting device 12 was started.

The results are shown in Figs. 4, 5, 6 and 7, wherein Fig. 4 shows data on measurement of positive ions obtained when the measurement was started at time 14:45. Measurement of positive ions took place for the reason that presence of positive ions in the atmospheric air before the measurement causes the

positive ions to be bonded to negative ions emitted from the negative ion emitting apparatus, leading to a failure in grasping the number of negative ions actually emitted. A reduction in the number of negative ions at an initial stage of the measurement in Fig. 5 would be due to the fact that negative ions bonded to positive ions fail to be counted.

The number of negative ions counted, the number of times of measurement and an average thereof were as follows:

(1) Start of measurement at 15:00 (the maximum value is not shown in Fig. 5):

10000 to 20000 ions/cc:	49 times
20000 to 30000 ions/cc:	60 times
Average:	8279 ions/cc

(2) Start of measurement at 15:15 (shown in Fig. 6):

0 to 100000 ions/cc:	18 times
100000 to 120000 ions/cc:	28 times
120000 to 140000 ions/cc:	74 times
140000 to 160000 ions/cc:	58 times
160000 to 180000 ions/cc:	76 times
Average:	137397 ions/cc

(3) Start of measurement at 15:35 (shown in Fig. 7)

1000 to 5000 ions/cc:	70 times
5000 to 10000 ions/cc:	144 times
10000 to 12000 ions/cc:	46 times
12000 to 14000 ions/cc:	28 times
14000 to 20000 ions/cc:	14 times
Average:	7960 ions/cc

A variation in numerical value during the measurement would be due to entrance and departure of people with respect to the meeting room in which the measurement was carried out during the measurement.

The above results clearly prove that the negative electron emitting apparatus of the present invention can emit a considerable number of negative ions.

5 Example 2

10 In order to compare the amount of each of positive ions and ozone emitted from the needle electrode of the negative ion emitting apparatus of the present invention used in Example 1 with that emitted from a conventional negative ion emitting apparatus utilizing corona discharge (manufactured by a certain manufacturer in Japan), the inventors requested Oki Engineering Co., Ltd. (Measurement Verifier Registration No. 595/Tokyo) to make the measurement.

15 Positive ions emitted cause nitrogen and oxygen in the air to be bonded to each other to produce nitrogen oxides. Thus, in the example, nitrogen oxides were measured.

 The measurement was carried out as follows:

20 Sampling of gas generated from the negative ion emitting apparatus was carried out as shown in Fig. 8. More specifically, the negative ion emitting apparatus 12 was kept at a rear portion thereof open and covered on a front side thereof or a negative ion generation side thereof with a vinyl sheet 15, followed by sealing of the apparatus 12 by means of an adhesive tape to prevent leakage from the apparatus. Then, the vinyl sheet 15 was
25 pursed up at a distal end thereof and a Teflon tube was securely connected to the distal end of the sheet 15 by means of an adhesive tape, to thereby permit a distal end of the tube to act as a sampling port. Then, two or first and second musette impingers 17 arranged in series, a flow meter 18, a diaphragm
30 pump 19 and an integrating flow meter 20 were connected to the apparatus in order. Sampling of gas generated from the apparatus was carried out for 20 minutes.

Measurement of nitrogen oxides took place using ion chromatography. More specifically, 10 ml of 0.3% hydrogen peroxide aqueous solution was used as a collecting liquid. Nitrogen monoxide and nitrogen dioxide were oxidized to a nitrite ion and a nitrate ion in the collecting liquid, resulting in being collected therein. Then, the nitrite ion and nitrate ion thus collected were subjected to quantitative determination by ion chromatography. Concurrently, nitrite and nitrate ions in the room were likewise determined (reference test) according to substantially the same procedure as described above. The latter measured values were subtracted from the former ones, to thereby calculate the amount of nitrogen oxides generated from the apparatus per unit time. In a hydrogen peroxide aqueous solution, a nitrite ion or nitrate ion in an amount of one mole is produced per mole of nitrogen monoxide or nitrogen dioxide. A mole of gas occupies a volume of 22.4 l at a temperature 0°C and a pressure of 10.3 kPa, so that the amount of nitrogen oxides generated per unit time is equal to a sum of a determined value of a nitrite ion and that of a nitrate ion.

Measurement of nitrite and nitrate ions in the collecting liquid was carried out using an ion chromatograph commercially available under a tradename IC7000P (temperature of constant temperature bath: 40°C, column: ICS-A44, eluting solution: 4.0 mmol Na₂CO₃/4.0 mmol NaHCO₃, removing solution: 15 mol H₂SO₄) from YOKOGAWA ELECTRIC CORP.

The results of measurement of a volume of nitrogen oxides generated per unit time carried out as described above are as follows:

Negative ion emitting apparatus

of the present invention	below 2 μ l/h
Conventional air cleaner	48 μ l/h

Ozone was measured using neutral potassium iodide techniques. More particularly, 13.61 g of KH_2PO_4 , 35.82 g of Na_2HPO_4 and 10.0 g of KI were dissolved in water to prepare an aqueous solution of 800 ml in volume and then a NaOH solution and a HCl solution were added to the solution to adjust pH of the solution to a level of 6.8 to 7.2. Then, water was added to the solution, to thereby obtain the solution of 1000 ml in volume, which was used as a collecting solution. Also, 0.1 mol/l I_2 solution of 10 ml in volume was prepared and HCL was added thereto, and the solution was titrated with 0.05 mol/l of $\text{Na}_2\text{S}_2\text{O}_3$ solution using starch as an indicator. Supposing that a titration value thus obtained is indicated at a ml, 0.1 mol/l of I_2 solution was taken in a volume of $89.3/(a \times f)$ ml (f: a factor of 0.05 mol/l $\text{Na}_2\text{S}_2\text{O}_3$ solution) and then water was added to the solution to obtain the solution of 100 ml in volume. Then, the solution was diluted to a concentration as large as one tenth with the collecting solution, to thereby obtain a standard solution.

Then, 10 ml of the collecting liquid was placed in each of the first and second musette impingers 17 shown in Fig. 8 and then an air sample was passed through the impingers for a predetermined period of time (10 to 30 minutes) at a suction speed of about 2 l/min. After passing of the air sample therethrough, water was added to the collecting liquid to increase a volume of the collecting liquid to 10 ml, to thereby obtain a test solution of 10 ml. Within 45 to 60 minutes after sampling, the test solution and standard solution each were stepwise diluted with the collecting liquid and then subjected to measurement of absorbance at a maximum wavelength near 350 nm, to thereby prepare a calibration curve (relational curve). Then, the amount of ozone (O_3) was obtained from the calibration curve, resulting in the amount of O_3 generated per unit time being

calculated.

The absorbance measurement was carried out using a commercially available visible spectrophotometer (UV 2000, absorption wavelength: 350 nm) manufactured by Shimadzu Corp.

The results of measurement of a volume of ozone per unit time are as follows:

Negative ion emitting apparatus	
of the present invention	below 2 μ l/h
Conventional air cleaner	48 μ l/h

The results clearly indicates that the negative ion emitting apparatus of the present invention generates only a trace amount of positive ions and ozone, which are not substantially detected.

While preferred embodiments of the invention have been described with a certain degree of particularity with reference to the drawings, obvious modifications and variations are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is Claimed is:

1. A negative ion emitting apparatus comprising:
a DC high-voltage power supply section;
at least one discharge electrode section; and

5 at least one load resistance section arranged between
said DC high-voltage power supply section and said discharge
electrode section so as to restrict flowing of electrons from
said DC high-voltage power supply section to said discharge
electrode section.

10 2. A negative ion emitting apparatus as defined in claim
1, wherein said DC high-voltage power supply section is connected
to said load resistance section and discharge electrode section
through a high-voltage wiring.

15 3. A negative ion emitting apparatus as defined in claim
1, wherein said discharge electrode section is constituted by a
needle electrode formed at a distal end thereof with an acute
angle.

20 4. A negative ion emitting apparatus as defined in claim
2, wherein said discharge electrode section is constituted by a
needle electrode formed at a distal end thereof with an acute
angle.

5. A negative ion emitting apparatus as defined in claim
1, wherein the amount of negative ions emitted is varied by
varying a load resistance of said load resistance section.

25 6. A negative ion emitting apparatus as defined in claim
2, wherein the amount of negative ions emitted is varied by
varying a load resistance of said load resistance section.

30 7. A negative ion emitting apparatus as defined in claim
3, wherein the amount of negative ions emitted is varied by
varying a load resistance of said load resistance section.

8. A negative ion emitting apparatus as defined in claim
4, wherein the amount of negative ions emitted is varied by

varying a load resistance of said load resistance section.

9. A negative ion emitting apparatus as defined in claim 1, wherein a plurality of said discharge electrode sections are arranged;

5 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

10 said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

10. A negative ion emitting apparatus as defined in claim 2, wherein a plurality of said discharge electrode sections are arranged;

15 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

20 said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

11. A negative ion emitting apparatus as defined in claim 3, wherein a plurality of said discharge electrode sections are arranged;

25 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

30 12. A negative ion emitting apparatus as defined in claim 4, wherein a plurality of said discharge electrode sections are arranged;

a distributor is arranged between said discharge

electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

5 said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

13. A negative ion emitting apparatus as defined in claim 5, wherein a plurality of said discharge electrode sections are arranged;

10 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

15 14. A negative ion emitting apparatus as defined in claim 6, wherein a plurality of said discharge electrode sections are arranged;

20 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

25 15. A negative ion emitting apparatus as defined in claim 7, wherein a plurality of said discharge electrode sections are arranged;

30 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

16. A negative ion emitting apparatus as defined in claim 8, wherein a plurality of said discharge electrode sections are arranged;

5 a distributor is arranged between said discharge electrode sections and said DC high-voltage power supply section and provided therein with an additional load resistance section; and

said DC high-voltage power supply section and said discharge electrode sections are connected to said distributor.

10 17. A negative ion emitting method comprising the step of connecting at least one load resistance section between a DC high-voltage power supply section and at least one discharge electrode section, to thereby restrict flowing of electrons from said DC high-voltage power supply section to said discharge electrode section for emission of negative ions from said discharge electrode section.

ABSTRACT OF THE DISCLOSURE

5 A negative ion emitting method and an apparatus therefor capable of emitting negative ions with increased efficiency without generating ozone and positive ions while being simplified in structure. The apparatus includes a DC high-voltage power supply section and a discharge electrode section, between which a load resistance section is arranged so as to restrict flowing of electrons from the power supply section to the discharge electrode section.

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DRAWINGS (7) SHEETS

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Title: NEGATIVE ION EMITTING METHOD AND
APPARATUS THEREFOR
Attorney's
Docket No.: KAM1-BL27

"EXPRESS MAIL" MAILING
LABEL NO. EL230378919US

DATE OF DEPOSIT: June 9, 2000

FIG. 1

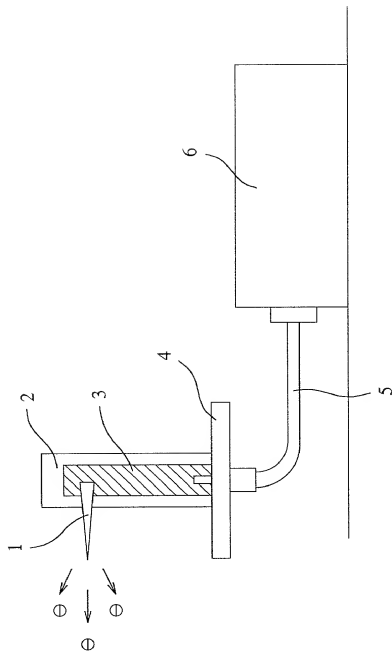


FIG. 3

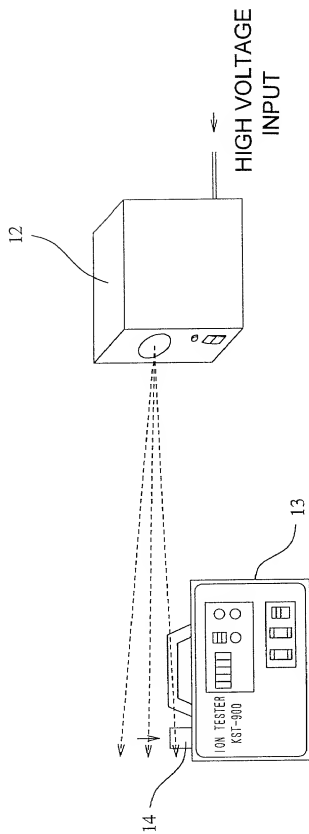


FIG. 4

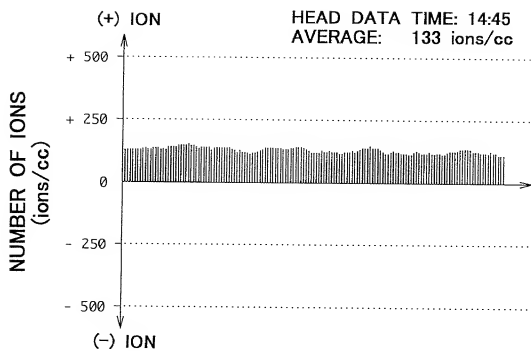


FIG. 5

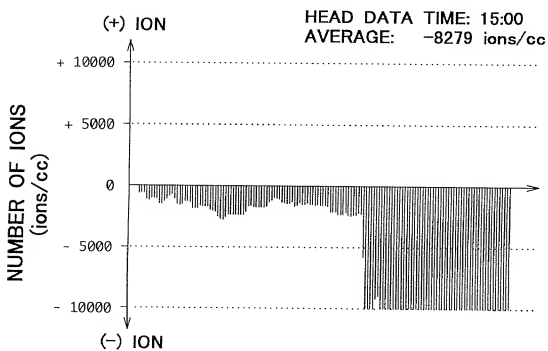


FIG. 6

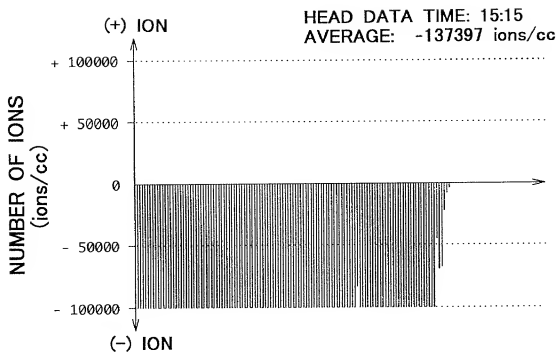


FIG. 7

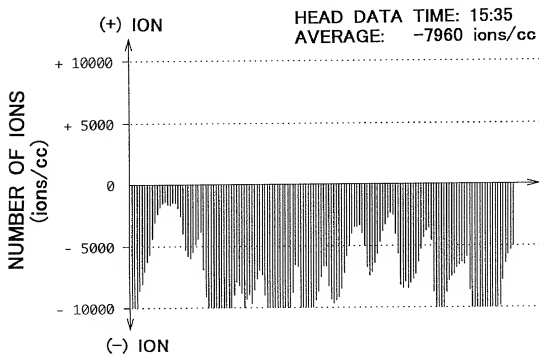


FIG. 8

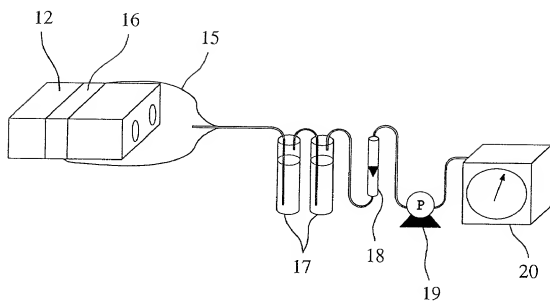
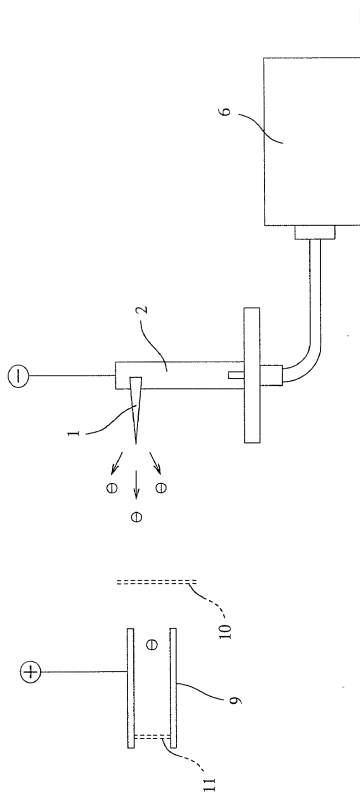


FIG. 9
PRIOR ART



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DECLARATION AND POWER OF ATTORNEY

Applicant(s): Yoichi Kato
Title: NEGATIVE ION EMITTING METHOD AND
APPARATUS THEREFOR
Attorney's
Docket No.: KAM1-BL27

"EXPRESS MAIL" MAILING
LABEL NO. EL230378919US

DATE OF DEPOSIT: June 9, 2000

COMBINED DECLARATION AND POWER OF ATTORNEY
IN ORIGINAL APPLICATION

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought, entitled:

Negative ion emitting method and apparatus therefor

the specification of which:

(check one)

☒ is attached hereto.

☐ was filed on _____ as

Application Serial No. _____

and was amended on _____

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56 (a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Foreign Application(s), if any, for Patent or Inventor's Certificate Filed Within 12 Months Prior to the Filing Date of This Application:

Country	Application No.	Date of Filing (Day, Month, Year)	Priority Claimed Under 35 U.S.C. 119
Japan	11-200752	11/06/1999	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
Japan	2000-107038	07/04/2000	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
			Yes <input type="checkbox"/> No <input type="checkbox"/>
			Yes <input type="checkbox"/> No <input type="checkbox"/>
			Yes <input type="checkbox"/> No <input type="checkbox"/>
			Yes <input type="checkbox"/> No <input type="checkbox"/>

All Foreign Applications, if any, for Patent or Inventor's Certificate Filed More Than 12 Months Prior to the Filing Date of This Application:

Country	Application No.	Date of Filing

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(1) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

(Application Serial No.)

(Filing Date)

(Status)
(patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment or both (18 U.S.C. 1001) and may jeopardize the validity of the application or any patent issued thereon.

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FULL NAME OF SECOND JOINT INVENTOR, IF ANY		INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP	
POST OFFICE ADDRESS			
FULL NAME OF THIRD JOINT INVENTOR, IF ANY		INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP	
POST OFFICE ADDRESS			
FULL NAME OF FOURTH JOINT INVENTOR, IF ANY		INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP	
POST OFFICE ADDRESS			
FULL NAME OF FIFTH JOINT INVENTOR, IF ANY		INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP	
POST OFFICE ADDRESS			
FULL NAME OF SIXTH JOINT INVENTOR, IF ANY		INVENTOR'S SIGNATURE	DATE
RESIDENCE		CITIZENSHIP	
POST OFFICE ADDRESS			